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Chamberlain Mfg Corp
IAD 04730771
Clinton
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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VII
324 EAST ELEVENTH STREET
KANSAS CITY, MISSOURI - 64106

OCT 28 1983

RECEIVED
OCT 31 1 18 PM '83
DEPARTMENT OF WATER, AIR AND WASTE MANAGEMENT

Mr. Paul Lundy
Department of Water, Air and Waste Management
Henry A. Wallace Building
900 East Grand
Des Moines, Iowa 50319

RE: Collis Corporation
Division of Chamberlain Manufacturing
Clinton, Iowa

Dear Mr. Lundy:

Enclosed for your information is a copy of the Phase I monitoring report on the above referenced site. Subject report was prepared by Terracon Consultants, Inc., for Collis and submitted to the Environmental Protection Agency (EPA) Region VII under the terms of the Resource Conservation and Recovery Act (RCRA) 3013 Consent Order.

At one time the Collis Site had interim status as a TSD facility. In 1981, Collis attempted to begin installation of groundwater monitoring wells. However, drilling could not be completed at that time when bedrock was encountered only a few feet from the surface of the ground. It was then agreed among Collis, EPA and Iowa Department of Water, Air and Waste Management (IDWAWM) (formerly Department of Environmental Quality) that Collis could delay installation of the monitoring wells required by the RCRA interim status regulations until adequate hydrogeologic information about the site had been developed to identify optimum well locations to satisfy the requirements of the interim status regulations, as well as the EPA uncontrolled site program.

Subsequently Collis may have elected not to operate as an interim status facility. You may, nevertheless, wish to share this report with your RCRA program.

Please contact me at (816) 374-6864 if anyone in IDWAWM has any questions or comments on the report. It will be the intention of EPA to provide comments to Collis no later than November 8, 1983.

Sincerely yours,

David O. Crawford

Dave Crawford
Sanitarian
Superfund Section
Waste Management Branch
Air and Waste Management Division

cc: Cheryle Micinski, CNSL
Don Sandifer, AWCM

R00312963
RCRA RECORDS CENTER

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HYDROGEOLOGICAL ASSESSMENT FOR
COLLIS DIVISION FACILITY AND
U. S. EPA REGION VII
CLINTON, IOWA PLANT
JOB NO. 783501

RECEIVED
OCT 31 1 18 PM '83
DEPARTMENT OF
WATER, AIR AND
WASTE MANAGEMENT

Terracon
CONSULTANTS, INC.

GEOTECHNICAL AND MATERIALS ENGINEERS

HYDROGEOLOGICAL ASSESSMENT FOR

COLLIS DIVISION FACILITY AND

U. S. EPA REGION VII

CLINTON, IOWA PLANT

JOB NO. 783501

Terracon
CONSULTANTS, INC.
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Gerald R. Olson, P.E.
James A. Cunningham, P.E.
Craig K. Denny, P.E.
John F. Hartwell, P.E.
Dennis L. Hoover

September 28, 1983

Chamberlain Manufacturing Corporation
Collis Division
Post Office Box 321
Clinton, Iowa 52732

ATTENTION: Mr. Robert Bell
General Manager

RE: Hydrogeological Assessment for
Collis Division Facility and
U. S. EPA Region VII
Clinton, Iowa Plant
Job No. 783501

Gentlemen:

Enclosed herewith are the results of the hydrogeological assessment performed for the above project.

In summary, bedrock surface varies from a few feet to in excess of 100 feet across the site. A buried bedrock ridge appears to bisect the site from northwest to southeast approximately centered on the building location. Considering the overlying unconsolidated materials, the northern portion of the site where the sludge settlement lagoons are located appears to be hydraulically isolated from the southern portion of the site. A detailed description of the site stratigraphy and geohydrology is contained in this report.

If there are any questions with regard to this report, or if we may be of further service to you in any way, please do not hesitate to contact us immediately.

Very truly yours,

TERRACON CONSULTANTS, INC.

John F. Hartwell, P. E.
Iowa #9451

Russell K. Lovaas, P. E.
Iowa #6161

JFH:RKL/sw

Other Offices In
Cedar Falls, Iowa
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Kansas City, Kansas
Wichita, Kansas
Oklahoma City, Oklahoma
Tulsa, Oklahoma

Geotechnical and Materials Engineers

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HYDROGEOLOGICAL ASSESSMENT FOR COLLIS DIVISION FACILITY AND U. S. EPA REGION VII CLINTON, IOWA PLANT

Job No. 783501
September 28, 1983

INTRODUCTION

The subsurface exploration and geohydrological assessment for the above-referenced project at the Chamberlain Manufacturing Corporation, Collis Division facilities, in Clinton, Iowa, has been completed. Soil borings were completed at twelve locations, and groundwater monitoring wells and/or piezometer points were installed at ten of these locations. The boring logs, location diagrams, plan and profile drawings depicting the geologic stratigraphy and groundwater contours as well as test results are included with this report.

The Site

The site observed in this study is the Collis Division plating facilities located at 2005 South 19th Street in Clinton, Iowa. The plant site is bounded on the north by Manufacturers Ditch, on the west by South 19th Street, on the south by an alley backing on a residential development, and on the east by a golf course.

Surface drainage in the northern half of the site is generally to the north or northwest and eventually drains into Manufacturers Ditch. The south half of the site drains toward the west-northwest and is intercepted by South 19th Street. Drainage flow from the southern half of the site enters the Manufacturers Ditch next to the 19th Street Bridge. Manufacturers Ditch flows southwest approximately 3500 feet to Mill Creek. Mill Creek runs approximately 5000 feet and drains into Beaver Slough, which in turn drains into the Mississippi River.

Sludge Settlement Lagoons

Based upon a drawing prepared by Collis labeled, "PL.43", dated 6-7-72, six lagoons had apparently been constructed sometime during the previous operation of the plant site. Part or all of four of the original six lagoons still existed at the time of this study. The area containing the original six lagoons is approximately 150 feet wide by 300 feet long, located near the northernmost corner of the plant site. Portions of the existing lagoons have been filled and the containment embankments graded level with surrounding ground. The approximate location of the existing sludge settlement lagoons is shown on Drawing 783501, Sheets 1A and 1B, in Appendix 4.

Purpose of Phase I

The purpose of this phase of study is to determine the unconsolidated stratigraphy geohydrology of the above described study area. Phase I of the environmental monitoring program was designed to permit an accurate preliminary assessment of the impact of past activities at the Clinton plant site upon the alluvial/surficial aquifer. In order to accomplish this, the geotechnical/geohydrological exploration program was formulated to determine the site geological conditions, which included identification of bedrock surface. Secondly, downhole instrumentation was installed to develop groundwater profiles and evaluate groundwater flow patterns within the surficial aquifer. Thirdly, instrumentation provided a means for obtaining groundwater quality samples from the surficial aquifer at the plant boundaries. The purpose of this report is to present the findings observed in this phase of the exploration program and to analyze site geohydrological conditions, particularly with regard to the potential for contaminant migration into the deeper bedrock aquifer.

Program Rationale

The initial borings performed were completed near the corners of the property to determine the character and distribution of unconsolidated sand and silt alluvium overlying the limestone bedrock anticipated at depth. Groundwater monitoring wells were installed at locations 1 through 5 to establish a generalized groundwater table for the site from which flow direction and velocities could be determined. These five groundwater monitoring points were also used to obtain groundwater samples from the surficial aquifer once the general flow directions had been determined. Data gaps in groundwater level information and alluvial stratigraphy were filled by completion of seven additional soil borings and installation of five additional piezometer points. Upon determination of the groundwater flow direction, background and downgradient groundwater monitoring wells were tentatively identified and the groundwater samples collected and analyzed.

A field log of each soil boring and monitoring well/piezometer point was kept by the supervising geologist. Finished boring logs showing physical soil test results, classifications, and well details are provided herewith.

The initial round of sampling occurred on May 31, 1983. This round of sampling included groundwater, stream and surface water, stream sediment, and soil sediment sampling. The purpose of this round was to determine qualitatively the presence of parameters of interest which included a number of priority pollutants in addition to general indicators of groundwater quality. The second round of sampling was performed on June 22, 1983. This round similarly included groundwater, stream and runoff surface water, stream sediment, and a larger number of surface soil samples. The ground and surface water samples were split three ways. Sample splits were provided to U.S. EPA Region VII, Collis, and SERCO Laboratories.

SAFETY PROCEDURES

In addition to standard safety equipment, which included the wearing of hard hats and safety shoes while working with the drilling equipment at the job site, rubber boots, gloves, and aprons or gowns were required to prevent skin contact with drilling fluids that might contain suspected contamination. Personnel were required to wash exposed skin surface upon departure from the site and before each meal taken at the site. Prior to initiation of field work at the northern half of the site in the vicinity of the sludge settlement lagoons, equipment safety level was upgraded to include wearing half-face or full-face respirators during drilling and sampling, and monitoring toxic gas emissions at the bore hole using a Draeger toxic gas detector provided by Ecology & Environment (EPA Region VII representative). Terracon personnel also monitored for toxic gas at the boring location using a Matheson-Kitagawa toxic gas detector with a 9-meter extension. Testing for ammonia and hydrogen cyanide was conducted continuously with negative results.

Laboratory safety procedures required the use of rubber apron and gloves while working with soil samples. Classification and testing was performed under exterior power-vented hoods when conducted in confined areas.

The supervising geotechnical engineer/ field geohydrologist established and monitored compliance with on-site safety procedures. All Terracon personnel were briefed by the Terracon project safety officer during the initial meeting at the site prior to commencement of field work. Entrance physicals and blood tests, along with entrance and exit urine testing, were performed on all Terracon field personnel.

SUBSURFACE EXPLORATION AND TESTING PROCEDURES

Drilling and Sampling

The borings were performed, and monitoring wells were installed with a track-mounted rotary-type drilling rig equipped with a hydraulic head for drilling and sampling operations. Track-mounted equipment was used because several boring locations were not accessible to truck-mounted equipment due to both terrain and weather conditions.

Soil samples were obtained using both split-barrel and shelby tube sampling procedures in accordance with ASTM Specifications D-1586 and D-1587, respectively. In the split-barrel sampling procedure, the number of blows required to advance a standard 2-inch O.D., 1 3/8-inch I.D., split-barrel sampler the last 12 inches of a typical total 18-inch penetration by means of a 140-pound hammer with a free fall of 30 inches is obtained as the standard penetration resistance value. This value is used to estimate the in-situ relative density of cohesionless soils and, to a lesser extent, the consistency of cohesive soils. In the shelby tube sampling process, a thin-walled, seamless, steel tube with a sharp cutting edge is pushed into the soil with hydraulic pressure to obtain a relatively undisturbed sample of cohesive or moderately cohesive soil. In each of the soil borings in which groundwater monitoring wells were to be installed and in borings 7 and 8, soil samples were obtained continuously to the bottom of the borings. In the remainder of the borings, the samples were obtained at approximate 5-foot intervals or major stratum changes, whichever occurred first.

It should be noted that special care was taken during drilling and sampling operations to minimize cross-hole and downhole contamination. Decontamination procedures consisted of washing drill rods, samplers, well casings, and screens by means of high-pressure hot water spraying. The water used in decontamination was nonchlorinated water obtained from a Collis plant well. In addition to drilling hardware, the drill rig was decontaminated between borings.

Routine Soil Sample Testing

The presence of gross contamination in the soil samples examined in the laboratory and in auger cuttings and split-spoon samples examined in the field was determined by a cursory visual examination. After preliminary classification, pH tests were performed on each soil sample using a Reading Scientific Model 55 Digital pH Meter equipped with a planer probe electrode. Upon completion of visual classification and field testing, soil samples were sealed, taped, and tagged for identification and listed on a chain-of-custody document control sheet prior to shipment to the laboratory for further testing.

Water contents, density, and cation exchange capacity tests were performed on representative portions of selected soil samples. All samples were examined in the laboratory by experienced personnel and classified in accordance with the General Notes and the Unified Soil Classification System based upon the texture and plasticity of the soils. The estimated group symbol for the Unified Soil Classification System is shown in the appropriate column of the boring logs, and a brief description of the classification system is included, along with the General Notes, in Appendix 1. Additionally, results of field pH and cation exchange capacity testing along with the other routine physical soil tests are shown in the appropriate columns on the boring logs, also included in Appendix 1.

GROUNDWATER MONITORING INSTRUMENTATION

Monitoring Wells

Five monitoring wells were installed. Upon completion of each boring, a well point consisting of a manufactured Schedule 40 PVC plastic .01-inch slotted, 2-inch diameter, well screen with a threaded bottom cap was positioned in the boring. Typically, the length of the well screen ranged from 5 to 10 feet. The screen was joined to a nonglued, flush-threaded, jointed, solid wall Schedule 40 PVC plastic riser pipe which was extended to about 3 feet above natural ground surface. Upon placement of the well casing and screen, a clean dry gravel pack was placed in the boring annulus to a height of at least 3 feet above the top of the well screen as the hollow stem augers were retracted from the boring. Above the gravel pack, the boring annulus was sealed to prevent vertical percolation of groundwater by installation of a typical minimum 3-foot thickness of tamped bentonite clay pellets. Above the bentonite seal, a cement-bentonite grout consisting of approximately six parts cement to one part bentonite by weight was placed to within 2 feet of ground surface. To provide for well point security and groundwater sampling integrity, a 4-inch steel protector pipe fitted with a lockable hinged cap was installed at each well point location. Each protector pipe was set in the boring annulus, and 2 feet of concrete was placed to ground surface. Following well point installation, each protector pipe was locked with a keyed-alike master padlock. Monitoring well construction details are shown on Drawing 783501, Sheet 5, Appendix 4.

Piezometer Points

Seven piezometer points were installed in completed soil borings to obtain more information on the surficial aquifer groundwater level. The piezometers were installed in a manner similar to the above-described monitoring wells, except that the point consisted of a 1-inch diameter, porous plastic pipe, 6 inches long, attached to flush-threaded, nonglued Schedule 40 PVC plastic 1-inch diameter pipe. Piezometer point construction details are shown on Drawing 783501, Sheet 5, Appendix 4.

SURFACE SOIL AND WATER SAMPLING

Six surface soil samples (SSS), two surface water stream samples (SWS) for water and sediment, and two surface water runoff samples (SWR) were located in the study area. Each sample location was marked with a 4" x 4" wood post set in concrete nearby. The posts were painted fluorescent orange with black lettering noting the sample indentification and location offset.

SITE AND SUBSURFACE CONDITIONS

Regional Geology

Clinton County is located along the central part of the eastern boundary of Iowa on the Mississippi River. The county is divided into several major areas of distinct physiography. The physiographic areas include the Kansan-Nebraskan Glacial Till Plain, the "Iowa Erosion Surface", and the alluvial flood plain associated with the Mississippi River, the Wapsipinicon River, and Goose Lake Channel. The Collis facility is positioned on the alluvial flood plain associated with the Mississippi River which lies along the eastern boundary of the county. The Collis facility is located on a portion of the Mississippi River flood plain which is currently drained by Manufacturers Ditch and Mill Creek. The area is dominated by nearly level, moderately well drained and poorly drained soils of the Colo and Sawmill Series. These poorly to moderately well drained soils are formed in silty alluvium on flood plains.

In this area, the surface topography does not reflect the top of bedrock surface which appears to be somewhat erratic. The surface unit of bedrock in Clinton County is Silurian, of Niagaran Age. The top of bedrock encountered in the study area appears to be the Anamosa Formation of the Gower Dolomite which is soft, yellowish brown, and thin-bedded.

Local Site Conditions

The study area is the Collis plant site. The site is approximately 570 feet wide from east to west by nearly 1100 feet long north to south and contains approximately 12.5 acres. Monitoring well 3 appears to be the lowest point on the plant site with a natural ground surface of 584.5. The water surface elevation of Manufacturers Ditch, measured April 13, 1983, was 579.8 feet. The north half of the site is relatively flat and level. South of the main plant building, the land begins to rise slightly uphill toward the southeast, with the highest point on the plant site being the southeast corner. Natural ground surface at MW-4 is 594.3 feet.

Twelve soil borings were performed in this phase of the monitoring program. A general location diagram showing the relative positions of these borings, monitoring wells, piezometer points, and other sampling points is shown on Drawing No. 783501, Sheets 1A and 1B. The borings performed as part of the field work for this study were located in the field by Terracon personnel. These locations were tied to a series of base lines established by the drilling crew. Angles were determined using a surveyor's transit, and distances were measured using a steel surveyor's tape. Elevations were determined using a surveyor's transit and referenced to two bench marks established by the City of Clinton along the South 19th Street right-of-way. Bench mark 1 is a monument pin inset in the east abutment of the South 19th Street Bridge across Manufacturers Ditch. The elevation of this monument is 587.22 feet, Clinton City Datum. A summary of these locations and elevations is presented both in Table No. 1 of Appendix 1 and on Drawing 783501, Sheets 1A and 1B, in Appendix 4.

Subsurface Conditions

Generally, the soils encountered at ground surface across the site were primarily clayey silts or silty clays. Alternating layers of clayey silts interbedded with varying thicknesses of fine to coarse sand or silty sand were encountered across the site. Depths to top of bedrock ranged from as deep as 118 feet in boring 12 to as shallow as 6 feet in boring MW-5. Limestone bedrock was encountered at the bottom of each boring and ranged from moderately to highly weathered. The color ranged from brown to yellow brown.

Based upon the borings performed, a buried bedrock valley appears to be present near the southwest corner of the site running approximately through boring 12 toward boring 9. Based upon soil borings performed by Terracon and others prior to this study, a second bedrock valley appears to form near the north central portion of the plant building and slope downhill toward the east-northeast with the center of the valley being between MW-5 and B-10P. The bedrock ridge appears to be present between MW-6 and MW-5 and, with the exception of the previously noted bedrock valleys, the bedrock surface appears to slope slightly downhill toward the north of this ridge.

In general, two systems of alluvial sands and gravels appear to be present in the unconsolidated soil materials located above the bedrock within the study area. A deeper system associated with the deep bedrock valley located at the southwest corner of the property was observed primarily in borings 11 and 12 with only a minor amount of coarse sand observed at the bottom of boring 9 just above bedrock. Overlying the alluvial sand, a thick zone of low plasticity clayey silts and silty clays was encountered in this buried bedrock valley as observed in borings 1, 9, 11, and 12. A shallow system of sands and gravels was encountered in each of these borings between elevations 565 and 585.

The surface soils encountered above the previously discussed bedrock ridge between MW-6 and B-10 indicate the absence of sands and gravels with clayey silt and silty clay alluvium occurring below fill material or natural ground and continuing to the top of bedrock except at boring 10, where approximately 6 feet of silty fine to medium sand was encountered above the bedrock. Across the northern half of the site where the sludge settlement lagoons are located, fill material, consisting of silt with varying amounts of clay, organic matter, and cinders and gravel and ranging in color from dark brown to dark gray, was encountered at ground surface and continued to depths ranging from 5 to 12 feet. Below the fill material, natural clayey silts or silty clays were encountered and continued to top of bedrock. The depth to bedrock ranged from 6 feet in MW-5 to 22 feet in B-8.

For a more detailed description of soils encountered in the borings, please refer to the attached boring logs. Stratigraphic profiles are shown on Drawing 783501, Sheets 3 and 4. The stratigraphic lines shown on the boring logs and stratigraphic profiles discussed herein represent the approximate boundary lines between soil and rock types; in situ, the transition may be gradual. The strata lines shown on the profiles are based upon interpolation between borings and may not represent actual subsurface conditions.

GROUNDWATER MONITORING PROGRAM

Groundwater was encountered in all borings, during both drilling and sampling operations and following casing removal. Water levels were detected at depths ranging from 2.5 feet in boring 5 to 14.3 feet in boring 4.

Well Development

Upon completion of the monitoring well installation, each well was equipped with a 1.5-inch O.D., Schedule 40 PVC bailer with a Teflon valve seat and Delrin ball check valve. Each bailer was approximately 5 feet long with an approximate bail volume of .042 cubic foot. The bailer was suspended from the PVC well cap by a multi-filament nylon rope attached to a threaded eyebolt. Each well was developed by bailing. Prior to bailing, the static water levels of the wells were measured using an acoustic well sounder attached to a measuring tape. Well development occurred between May 12th and May 17th. Each well was bailed dry three times during this time period. Water samples obtained during development were tested in the field for temperature, pH, and specific conductance to determine completion of well development. In each case, temperatures remained relatively constant between 11°C and 13°C. The pH ranged from as low as 7.0 to 9.0, and specific conductance remained nearly constant at each well location but ranged from a high of 3900 microhms per centimeter in MW-2 to a low of approximately 700 in MW-1. Monitoring well development records are shown on Table No. 3, attached herewith.

Bailing Tests

Bailing tests were conducted on the five monitoring wells installed. The tests were performed four days after the initial well purging, and initial static water levels used for determination of hydraulic conductivity were those measured just prior to the second round of purging. In this test, the water is bailed from the well to achieve a measurable amount of drawdown within the well casing, and the rate of recharge is then measured immediately following the withdrawal of the final bailed volume. This initial rate of recharge is used to approximate the original rate of inflow into the well, and an average horizontal hydraulic conductivity is calculated using a method presented by Hvorslev in 1951 for a point piezometer in a unconfined aquifer, using the following equation:

$$K = \frac{r^2 \ln(L/R)\ (2.54\ \text{cm/in})}{2LT_o} \qquad \text{Where } T_o = V/q_o$$

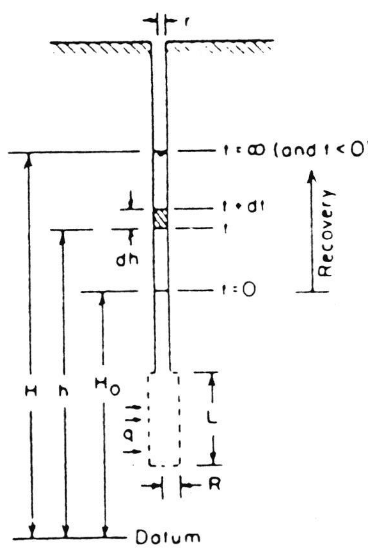
$q_o = (f)\,\pi r^2$ = Flow Rate

$V = \pi r^2 (H-H_o)$ = Volume of Water Removed

L = Length of Saturated Annulus Below the Bentonite Seal

r = 1.03 in.

R = 3.13 in.



The results of these field tests are presented in Table No. 4 of Appendix 1.

Water Level Monitoring

Groundwater level observations were made by Terracon personnel on several occasions from May through August 1983. Water levels reported are accurate to within .1 foot. Each well was purged following the completion of the water level measurements except after the August 12th readings. The results of the observations obtained during development and sampling activities are shown on Table No. 5 of Appendix 1 of this report. Additionally, groundwater contour maps were prepared from readings obtained on May 16 and August 12, 1983. These maps are shown on Drawing 783501, Sheets 1A and 1B, included in Appendix 4.

At MW-1 and B-9P, staged monitoring well or piezometer points were installed. The purpose of the shallow/deep staged configuration of the monitoring points was to obtain vertical hydraulic gradient data. Weathered limestone bedrock was encountered at the bottom of each boring, and in both cases, upward vertical gradients were observed upon completion of the monitoring points. Upward vertical gradient at B-9P was observed to be 5.5%. At MW-1, the upward gradient was 1%.

Horizontal gradients were estimated along the apparent flow paths of groundwater moving in the alluvial silts and clays perpendicular to the contours on Drawing 783501, Sheets 1A and 1B, Appendix 4. Horizontal gradients ranged from approximately 6% at the southern portion of the study area to an average of 1% or less at the northern end of the study area. Maximum gradients, particularly in the areas surrounding the lagoons, may be greater than indicated by the nearest monitoring points. Data obtained represents groundwater conditions at the perimeter of the site.

ANALYTICAL SAMPLE COLLECTION AND TESTING

Procedures

Soil Boring Samples

Soil samples obtained from the twelve soil borings positioned around the perimeter of the site were classified by the field geologist and tested for pH prior to being double-tagged, sealed, and logged on chain-of-custody documentation. Samples were transferred to Terracon's laboratory in Cedar Rapids for the routine classification and testing described in a previous section entitled "Subsurface Exploration and Testing Procedures". In the Cedar Rapids office, the samples were extruded, classified, split and placed in labeled containers. Portions of the samples were retained at the Cedar Rapids laboratory for routine testing. The duplicate split set of soil samples was transferred to the Terracon office in Lenexa, Kansas, for cation exchange capacity testing.

Groundwater Sampling

Terracon personnel collected groundwater analytical samples from each of the monitoring wells using each well's bottom discharge PVC bailer. Immediately before sampling, the groundwater surface elevation was determined. Although originally it was intended that a minimum of three times the standing water volume of the well casing would be removed prior to obtaining a sample, the standing water volume and recharge rates were generally insufficient to obtain an analytical sample within the desired time intervals.

In the first round of sampling, samples were obtained by Terracon personnel under the direction of a field chemist representing SERCO Laboratories, Inc. Also witnessing the testing were U.S. EPA Region VII representatives from Ecology & Environment and representatives from Collis Division. Groundwater samples were placed in containers provided by SERCO Laboratories. Samples were collected for metal, TOC, cyanide, and hexavalent chromium testing. Water samples obtained were immediately filtered in the Collis laboratory under the supervision of SERCO personnel using a vacuum pump and evacuation flask before being placed in bottles containing sample preservatives. No split samples were obtained for Collis or U. S. EPA during this round of sampling. Following completion of chain-of-custody documentation, the samples were packaged in chilled containers and transferred to SERCO Laboratories in Cedar Falls, Iowa.

The second round of groundwater sampling occurred on June 20, 1983. This sample round was conducted using the same procedures as described for the first sample round except that sample splits were provided for both Collis and U.S. EPA. As part of the EPA testing program, additional samples for volatile organics and priority pollutants were obtained. Metal samples were filtered in the Collis laboratory using microfiberglass filters and an aspirator funnel prior to being placed in sample containers. Raw groundwater samples were transported to the Collis laboratory for filtering in solvent-rinsed glass containers. See Tables No. 6 and No. 7, Appendix 1, for sampling record details.

Surface Water Sampling

Stream (SWS)

Two surface water stream samples were obtained from the Manufacturers Ditch located along the northern boundary of the site. The background sample was obtained at SWS-1 near the intersection of an extension of the east property line of the plant site with Manufacturers Ditch. The downstream sampling point (SWS-2) was located about 800 feet downstream from the Collis plant effluent discharge point into the Manufacturers Ditch. These locations are shown on Drawing 783501, Sheets 1A and 1B.

During the first round of sampling on May 31, 1983, surface water stream samples were obtained just upstream of the line formed by the dual sample marker posts. Samples were obtained at midstream at mid-depth. Prior to collection of the samples, each sample bottle was rinsed with stream water immediately downstream of the sampling point. Sample bottles were then marked, sealed, and packaged. Following completion of chain-of-custody documents, samples were transferred to SERCO Laboratories in Cedar Falls, Iowa, for analytical testing.

The second round of sampling occurred on June 20, 1983, and was identical to the first round of sampling except that split samples were provided to Collis.

R u n o f f (SWR)

Surface water samples from runoff puddles located between the main plant building and the lagoon system were obtained at the locations marked on Drawing 783501, Sheets 1A and 1B, during both rounds of sampling. The surface water runoff sample was obtained in a manner similar to that described for surface water stream samples. Care was taken to avoid stirring sediments during the collection process.

Surface Soil Sampling (SSS)

Five surface soil sample locations were selected adjoining the existing lagoons located at the northern portion of the study area. Four of these locations bordered the perimeter of the lagoon system with the fifth being located near the system center. Surface soil samples were taken from the upper 18 inches of the soil strata. Samples were quartered in the field on a clean plastic sheet. The sample was then placed in a solvent-rinsed glass container, sealed, documented, and shipped to SERCO Laboratories for analytical testing.

To minimize cross-contamination, the sampling device was carefully rinsed with soap and distilled water after each set of samples was collected. New plastic quartering sheets were used at each sample location. During sample collection, the soil was visually and tactually examined and classified in accordance with the attached General Notes and Unified Soil Classification System. Such things as general moisture content and the presence of organic substances were also noted.

Sediment Sampling (SWS)

Prior to sampling each stream surface water point, stream sediment samples were obtained just downstream of the water sampling point. The sample point was typically 12 inches deep and centered in the stream. The sediment sample was placed in a solvent-rinsed glass jar, sealed, tagged, and documented for shipment to SERCO Laboratories. Stream sampling during both rounds of testing started with the downstream sample first, followed by the upstream sample, to minimize the effect of stream disturbance on the collected samples.

Documentation

Each groundwater and soil sample collected was labeled with a minimum of one self-gummed identification seal in addition to an identification tag. On each of these labels, the date and time of sample collection, the sample identification and location, type of sample, and the individual collecting the sample were noted. Chain-of-custody documents were completed for each soil and water sample obtained following sample collection and sealing. Documentation followed each sample set throughout the testing and classification sequence. For each custody change, the receiving custodian inventoried the samples and noted date of receipt on the appropriate document. Following completion of the inventory, the individual signed the chain-of-custody document. Appendix 2 contains examples of the identification seals used and a complete set of chain-of-custody documentation for samples collected and tested by Terracon Consultants and SERCO Laboratories.

ANALYTICAL METHODOLOGIES

The analytical testing program involved testing all soil and water samples obtained at the study area except for soil samples obtained from the twelve soil borings performed at the site. Analytical samples consisted of groundwater samples, stream water and sediment samples, surface water runoff samples, and surface soil samples as described above. Each sample collected during both sampling rounds was analyzed for arsenic, cadmium, total chromium, hexavalent chromium, copper, mercury, nickel, zinc, lead, total cyanide, amenable cyanide, and total organic carbons (TOC). The analyses were performed by SERCO Laboratories of Cedar Falls, Iowa. The analytical methods used are shown on Table No. 8 of Appendix 1.

Sample splits were made in the field for Collis and U.S. EPA Region VII. Additional analyses to be performed by U.S. EPA Region VII included volatile organics and priority pollutants.

Additionally, routine testing performed on soil samples obtained from the soil borings included pH, specific conductance, and cation exchange capacity (CEC). These tests were performed by Terracon Consultants either in the field or in a laboratory environment. Analytical methods used are also indicated on Table No. 8 of Appendix 1.

ANALYTICAL RESULTS

The results of chemical analyses performed by SERCO Laboratories and field testing performed by Terracon Consultants for the above-described analytical samples are presented in Table No. 9 of Appendix 1. Original analytical results transmitted by SERCO Laboratories are included in Appendix 3. The results of routine field pH tests and cation exchange capacity tests performed by Terracon Consultants on soil samples obtained from the twelve perimeter soil borings are shown on the boring logs included in Appendix 1.

The population range for each analytical test set greater than 1 was determined using "Student t" analysis for a confidence interval of 80%. When the lower limit of the sample population was calculated to be less than zero, the concentration was truncated and expressed as zero. The results of the statistical analysis are shown as parameter population ranges for lagoon soils, stream water and sediment, and surface runoff samples collected in Tables 10, 11, and 12 of Appendix 1.

Statistical evaluation of apparent upgradient and downgradient groundwater samples obtained from the five perimeter monitoring wells has not been made, pending receipt of the analytical results of sample splits provided U.S. EPA Region VII. However, none of the measured concentrations for arsenic, cadmium, chromium, lead, or mercury exceeded the maximum allowable concentrations of constituents for groundwater protection as listed in CFR40, Part 264.94 (a) (2) Table 1.

Statistical analysis of the routine testing performed on soil samples obtained from borings located at the perimeter of the study area is presented in Table No. 14 of Appendix 1. Soil borings were grouped into two groups. Soil borings 2, 3, 5, 7, and 8 were separated from the remaining borings due to their proximity to the sludge settlement lagoons. The remaining borings (1, 4, 6, 9, 10, 11, and 12) are considered to be the background group. Analysis of the soils with regard to cation exchange capacity (CEC) and pH testing was further subdivided by soil type. Generally speaking, finer-grained soils such as CL, ML, and CL-OL exhibited CEC ranging from 18 to 30 milli-equivalents of ammonia per 100 grams of soil. The soils obtained from borings located in the vicinity of the sludge settlement lagoons had CEC somewhat higher than comparable soils of the background group. Soils classified as CL-OL had a mean CEC of 43, and fill material observed at ground surface in several of these borings exhibited CEC on an average of about 31.

ANALYSIS

Site Stratigraphy

Bedrock surface across the study area bears little resemblance to the relatively flat and level ground surface at the site. Depths to bedrock from ground surface range from a few feet in the north central and southeast corners of the site to nearly 120 feet near the southwest corner. (See the Isopach map contained on Drawing 783501-2 of Appendix 4.) The surface bedrock unit is a weathered brown to yellowish brown water bearing limestone. The buried bedrock valley located in the southwest corner of the study area appears to have been filled primarily with fine-grained, relatively low-permeability alluvial sediments. Two separate systems of coarse-grained, more highly-permeable sand and gravel alluvial material were observed in the borings and are depicted on the stratigraphic profiles shown in Drawing 783501, Sheets 3 and 4, in Appendix 4. The lower unit consists of sands and gravels encountered just above bedrock in borings performed at the southern end of the site. The bottom of the upper system of sands and gravels appears to range from approximately elevation 565 at the south end of the site to elevation 575 near the east central portion of the site. The sand and gravel seams range in thickness from 15 to 20 feet at the south end of the site to from 5 to 10 feet at the central part of the site. Significant sand seams do not appear to extend north of the bedrock ridge which runs generally from boring 5 to boring 6. North of this line, unconsolidated sediments consist primarily of fine-grained silts and clays topped by organic silts or fill material placed during or following site development.

Site Geohydrology

Groundwater within the unconsolidated sediments located above the bedrock surface flows generally from the southeast to the northwest across the site. During the monitoring period of May through August 1983, groundwater on the site was recharging Manufacturers Ditch. Groundwater flow direction within this surficial aquifer varies significantly from this general southeast to northwest trend. South of the bedrock ridge located in the vicinity of the plant, the groundwater flow has a northward direction at the eastern edge of the study site and a western flow direction along the south boundary. At the north end of the site, flow appears to split along a line from boring 10 to boring 7, with flow north of that line moving almost due north and flow west of that line moving to the west or southwest. Some variation in flow directions and gradients due to seasonal fluctuation in recharge conditions may be observed by comparing the two water level contour maps shown on Drawings 783501-1A and 1B in Appendix 4.

Horizontal groundwater flow gradients range from as high as an average of 1% between piezometer points located at B-11P and B-9PA to as low as .1% between B-10P and MW-2. The average horizontal hydraulic conductivities for the screened intervals of wells positioned in fine-grained sediments range from approximately 3 to 9 x 10^{-7} cm/sec. Effective horizontal groundwater velocities in the fine-grained alluvium range from 1 x 10^{-2} to 1 x 10^{-3} feet per year.

Shallow/deep staged monitoring points located at B-9P and MW-1 indicate upward vertical gradients ranging from 1% to 6% between bedrock wells and wells located within the overlying unconsolidated sediments. Horizontal groundwater flow gradients in the bedrock range from .5% between MW-4 and MW-5 to 1.5% between B-9PB and MW-1. Based upon slug-out tests performed at monitoring wells 4 and 5, horizontal hydraulic conductivities in the bedrock range from 3 x 10^{-4} to 5 x 10^{-5} cm/sec. Given these horizontal flow gradients in the bedrock, groundwater flow velocities within this bedrock could range from 100 to 500 feet per year.

Vertical groundwater flow velocities within the fine-textured alluvium are assumed to be at least an order of magnitude less than that observed for the horizontal flow velocities. This assumption is based upon the typical anisotropic permeability conditions encountered in a layered soil system.

Contamination Migration

The contamination present in the sludge settlement lagoons may be expected to migrate hydraulically downgradient in the uppermost groundwater aquifer. In the vicinity of the sludge settlement lagoons, the uppermost aquifer consists primarily of fine-grained sediments and fill material. Groundwater was observed to be present at ground surface in the vicinity of boring 3 and a marshy area located between boring 8, monitoring well 3, and the sludge settlement lagoons. In our opinion, groundwater flow from the sludge settlement lagoons should be north to northwest toward Manufacturers Ditch. Based upon the limited amount of data available regarding the site stratigraphy and geohydrology in the immediate vicinity of the sludge settlement lagoons, we feel that contaminant migration will be limited to the upper portion of the unconsolidated sediments and fill material.

Due to the absence of higher-permeability sand seams in the borings in this vicinity, migration of contamination great distances horizontally offsite or vertically to the bedrock surface does not appear probable by means of advective flow. However, groundwater monitoring information is limited in the area immediately surrounding the sludge settlement lagoons, and minor seams of higher permeability sands or silts could be present in the adjoining fill material and natural alluvium. Offsite migration of contamination at velocities much higher than the estimated 1×10^{-2} or 10^{-3} feet/year could then be possible.

Preliminary analysis of groundwater samples obtained from the perimeter wells does not appear to indicate contribution by the Collis facility for the parameters tested. We believe, based upon available information, that contaminant migration is presently confined to within a few feet of the sludge settlement lagoon boundaries, both horizontally and vertically.

It is our opinion that bedrock groundwater contamination from the sludge settlement lagoons has not occurred to date. However, due to the relatively shallow location of the bedrock within this area and the unknown original depth of the sludge settlement lagoons, contamination of the bedrock aquifer may be considered a possibility.

GENERAL COMMENTS

The analysis presented in this report is based upon the data obtained from the soil borings and monitoring wells completed at the indicated locations and any other information discussed in this report. This report does not reflect any variations that may occur between borings or across the site.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made. In the event that any changes in the nature of the project as outlined in this report are planned, the analysis contained in this report should not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing by the geotechnical engineer / geohydrologist.

A P P E N D I C E S

L I S T O F A P P E N D I C E S